

CHANGES IN THE VEGETATION OF HLUHLUWE GAME RESERVE, ZULULAND, AS REGULATED BY EDAPHIC AND BIOTIC FACTORS OVER 36 YEARS

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ABSTRACT

Examination of two sets of vegetation data showed a 5% increase in the extent of Forest in the Reserve during the period from 1937 to 1974. A corresponding decrease of 8% was found in the extent of Grassland. A considerable increase in the woody element of the vegetation at the expense of the herbaceous layer, particularly grasses, was evident even when allowance was made for a possible mapping error equivalent to one percent. These changes were mostly confined to upland areas and were ascribed to possible differences in burning treatments applied over the period. No significant changes were found in the areal extent of lowland communities where soils were primarily responsible for community distribution. However, soil erosion in the lowlands was ascribed to a reduction in herbaceous cover and, possibly, an increase of woody plants.

UITTREKSEL

VERANDERING IN DIE PLANTEGROEI VAN HLUHLUWE WILDRESERVAAT, ZULULAND, SOOS BEHEER DEUR EDAFIESE EN BIOTIESE FAKTORE OOR 36 JAAR

Die ontleding van twee stelle gegewens oor plantegroei het 'n toename van 5% in die woudbedekking van die reservaat vanaf 1937 tot 1974 aangedui. Die omvang van grasveld het terselfdertyd met 8% verminder. Die houtagtige komponente van die plantegroei het geweldig toegeneem ten koste van die kruidagtige laag, veral grasse, selfs met inagneming van 'n moontlike karteringsfout van een persent. Die verandering was hoofsaaklik tot hoërliggende dele beperk en is aan moontlike verskillende brandbehandelings gedurende die tydperk toegeskryf. Geen beduidende verskille in die omvang van laerliggende plantgemeenskappe is gevind nie. Verspreiding van hierdie gemeenskappe is hoofsaaklik deur grondsoorte bepaal. Gronderosie in die laagliggende gebiede is egter aan 'n afname in kruidagtige bedekking en moontlik 'n toename in houtagtige bedekking toegeskryf.

INTRODUCTION

During 1936 Dr J. S. Henkel investigated the plant and animal ecology of the Hluhluwe Game Reserve, paying particular attention to possible relationships between the vegetation and breeding habits of tsetse flies. This work, done at the request of the Natal Provincial Council, was published together with a vegetation map in the following year (Henkel, 1937). A study of the same area by the author in 1973 aimed at producing vegetation information generally useful for management purposes, and the results were reported to the Natal Parks Board (Downing, 1974).

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This present paper aims to investigate, through a comparison of the 1937 and 1974 reports, the nature of any vegetation changes that might have arisen during the interval of 36 years.

METHOD

A first step was to relate the names of the various communities described in the two reports so that a single title could be allocated to each community. This was accomplished by reading of the two texts and comparison of the two vegetation maps. The eleven communities of the second report were thus reduced to correspond with the six communities mapped in the first report.

Copies of each of the two maps were made, and the separate areas representing the five communities were excised. The total area of each community was then estimated by means of an electronic planimeter; and the community areas were expressed as a percentage of the whole.

Visual comparisons of the distributions, shapes and areas were also made on intact copies of the maps in order to assess overall changes between the communities.

RESULTS

Community Comparison

The results summarised in Table 1 show the relationships between communities, zones and regions in the two surveys. The number quoted for the mapping units of Henkel (1937) will be used as a simple way for referring to a community. Communities having a similar number were mapped as a single unit.

Most of the eleven communities described in 1974 were fairly easily related to the equivalent communities described in 1937. This was the case for Forest (unit 1), for Grassland and Parkland (unit 2). The Floodplain Grassland of 1974, not mapped separately in 1937, was incorporated as part of unit 2. The *Acacia-Ficus* Riverine Forest of 1974 corresponded with unit 5. The *Acacia burkei* Riverine Forest of 1974 was related to *Spirostachys* Parkland (unit 3) after environmental and distribution data were found to match. The *A. burkei* Closed Woodland was also accommodated, after matching, by unit 3. The remaining communities of 1974, comprising thicket and closed woodlands, were all similar to unit 4, the *Euclea-Combretum* Association of 1937. A problem arose from the *Dichrostachys-A. karroo* Association (unit 6) which was mapped separately in 1937 but which was included as part of the *Acacia* Wooded Grassland (unit 2) of 1974. Unit 6 was therefore included as part of unit 2. Thus were the eleven communities of 1974 related to five map units (reduced from six) of 1937.

TABLE 1.
A comparison of the communities and mapping units in Hluhluwe Game Reserve obtained by relating Henkel (1937) to Downing (1974).

Zone	COMMUNITIES OF HENKEL (1937)			COMMUNITIES OF DOWNING (1974)	
	Community name	Map Unit		Community name + map unit	Region
Humid Upland	Evergreen Closed Forest	Closed Forest	1	Forest	High-land
	Themeda Grassland	Grassland	2	<i>Themeda-Cymbopogon</i> Dry Grassland	
	Deciduous Parkland <i>A. caffra</i> + <i>Cussonia</i> sp.	Grassland	2	<i>Acacia</i> Wooded Grassland	
Inter-mediate	Parkland <i>A. nilotica</i> + <i>A. karroo</i> (with <i>Sclerocarya</i>)	Grassland	2	<i>Sclerocarya</i> Open Woodland	
—	—	—	2	Floodplain Grassland	Riverine
	Closed, Fringing, Riverine Forest	Riverine Forest	5	<i>Acacia-Ficus</i> Riverine Forest	
Dry Valley	Parkland of <i>Spirostachys</i> Tree Association (on silt)	Alluvial Sand	3	<i>Acacia burkei</i> Riverine Forest	
	Parkland of <i>A. burkei</i> Tree Association (on sand)	Alluvial Sand	3	<i>A. burkei</i> Closed Woodland	Lowland
	<i>Euclea-Combretum</i> Shrub Association	Scrub Lowlands	4	<i>Euclea</i> Thicket	
			4	<i>Combretum</i> Closed Woodland	
	<i>Dichrostachys-A. karroo</i> Shrub Association	Scrub Lowlands	6	<i>Spirostachys</i> Closed Woodland (= <i>Acacia</i> Wooded Grassland)	

Change in Areal Extent

TABLE 2.

A comparison of the areas of communities mapped by Henkel (1937) at a scale of 1:31 543 and by Downing (1974) at a scale of 1:25 000 in Hluhluwe Game Reserve.

Unit	Type	1937		1974		% Change
		Area cm ²	% Total	Area cm ²	% Total	
1	Forest	191,62	12	415,85	17	+5
2 + 6	Grassland	748,40	49	984,04	41	-8
3	Alluvial Sand	81,99	6	243,16	10	+4
4	Lowland Scrub	436,11	28	594,34	25	-3
5	Riverine Forest	75,49	5	138,78	6	+1
—	Hluhluwe Dam	—	—	12,91	1	—
	Total	1 533,61	100	2 389,08	100	

Table 2 gives the results of planimetry and the estimated percentage increase or decrease in the areal extent of the communities between 1937 and 1974. The area of the Hluhluwe Dam is included at 1 % of the total. The Dam was built after 1960 and would have flooded roughly equal proportions of units 2 to 5 inclusive. The effects on the results are regarded as being almost negligible.

Riverine Forest (unit 5) shows a small increase of 1 %. This change is more likely due to technical error in map drafting than to any real change.

A 4 % increase in Alluvial Sand (unit 3) also seems mostly ascribable to a technical difference because the extensive *Acacia burkei* dominated stands mapped in 1974 as separate entities were added to unit 3. Fewer of these stands were separately mapped in 1937 and these were mostly regarded as part of the Lowland Scrub (see Henkel, 1937, p. 18 section 7). The 4 %, "false" increase of unit 3 is thus complementary to the 3 %, probably false, decrease of Lowland Scrub (Table 2, unit 4) which resulted from transfer of some *A. burkei* stands from the latter to the former during the 1974 survey.

The only real changes in areal extent would thus seem to be in the Closed Forest, which evidently increased by 5 %, and in the Grassland which evidently decreased by 8 %.

DISCUSSION

Initially, comparison of the 1937 and 1974 vegetation maps was attempted by optical enlargement of the former (at an original scale of about 1:31 543) to the 1:25 000 scale of the latter. This was abandoned because the two would not

match. The 1937 map was found to have a small distortion error, equivalent to 8 mm over the north-south distance of the map when compared to the 1974 map. Also, the shapes of some community boundaries were somewhat different, showing even a rotation through several degrees. The differences probably arose because Henkel, in the absence of any proper base map, had to survey the area *ab initio* by using a compass and aneroid barometer, both of which were also used to fix the vegetation boundaries. Small survey errors were likely to have resulted on occasions from magnetic deviations, as could be induced by dolerite outcrops, and by diurnal fluctuations in atmospheric pressure. Such errors were precluded from the 1974 map where topographic features were based on accurate sheets produced by the Trigonometric Survey; and where the distribution of community boundaries could, relatively easily, be seen on airphotos.

The errors in Henkel's work are nevertheless small, and the accuracy of his survey is quite remarkable considering the rather primitive instruments used. Henkel was invited to do the survey by the provincial government because he was known as a methodical and meticulous worker (Professor A. Bayer, pers. comm.)—a point confirmed by Table 3 which compares the spot heights obtained by Henkel (1937) with those obtained by modern survey. The maximum differences are by 100 feet, but with some only a few feet are involved. Similarly, the configurations of his contours, streams and rivers differ only slightly against the modern map. The vegetation data of Henkel, an experienced botanist and forester, can thus reasonably be expected to be rather accurate and reliable.

TABLE 3.

A comparison of altitudes (in feet) determined by Henkel (1937) in Hluhluwe Game Reserve as against altitudes given by recent Trigonometrical Survey on the South Africa 1:50 000 sheets.

Place	Altitudes in feet	
	Henkel	Trig. survey
Mthole (spot height)	1 524	1 529
Zangomfe (spot height)	1 135	1 141
Magwanxa	1 300	1 200
Sivivaneni	1 100	1 000
Umdindwana beacon	1 600	1 600

These expectations are confirmed by the closely similar extent of Riverine Forest, unlikely to change in area over time, which differed by only 1 % between 1937 and 1974. The narrow, fringing nature makes difficult delineation and measurement of Riverine Forest and, as mentioned previously, this difference is probably of a technical origin. An allowance of 1 % might thus be permitted for technical errors when comparing changes in the extent of the remaining communities—notwithstanding, of course, that a 1 % increase or decrease in

extent of a community over 40 years could be most important in conservation terms.

The increase of Alluvial Sand, and decrease of Scrub, in 1974 have already been explained in terms of differences in classificatory approach between the two authors, and as being mostly of a technical nature. Overgrazing, a cause of sparse grass cover and soil erosion, has sometimes been cause for concern in the Lowland Scrub during recent times. However, similar or fairly similar conditions prevailed earlier in the *Euclea* communities where Henkel (1937, pp. 16, 18) made the following comments.

- (a) The grasses are so heavily grazed that there is not enough inflammable material to support a fire.
- (b) Game animals seem very fond of these shrubby areas.
- (c) The ground herbage is not abundant, particularly on hot aspects where much bare soil is exposed.

Henkel (1937) did not mention the presence of gullies which are nowadays conspicuous. The recent origin of many gullies is demonstrated by freshly exposed roots and toppled, but still living, trees near the gullies. Grass cover might thus have deteriorated a little since 1937.

A real increase in the extent of Closed Forest seems probable even if not as high as the 5 % given in Table 2. Henkel (1937, p. 22) mentioned that the dense, abrupt Forest margins were not damaged by fires which regularly burned through the adjacent Grassland and Parklands. However, Mr R. Porter (pers. comm.) has recently observed fire damage. Advances and retreats of margins at different localities, depending on the extent of fire immunity or damage at various localities from one year to the next, may well account for differences in the shapes of some Forest stands between 1937 and 1974.

Most stands of Forest occur on high hills, a topographic situation where the areal extent is exaggerated when studied on airphotos through a stereoscope. Such exaggeration was countered, as far as possible, during the 1974 study and any residual exaggeration should have been off-set by exaggeration from Grassland which also grows on the hills. An overall increase of Forest is, however, confirmed by the presence of a few, not previously mapped, fairly extensive stands of Forest as found south of Hlaza and N'kwanka Hills.

The extension of Forest has, logically, been at the expense of the adjacent Grassland which shows a decrease of 8 % in spite of several rather "woody" or "wooded" categories of the 1974 survey being included as part of the Grassland. Definition and classification is difficult for the vegetation series which covers the range from pure grassland, through varying degrees of woody establishment, to Savanna, Parkland, Open Woodland or even Thicket. Any equilibrium position on this series is often determined by a combination of fire behaviour and browsing (see Trollope, 1974). Changes in the effective interactions between these two factors and the vegetation probably account for the evident increase in the woody

element of Grassland and near-Grassland types in the Humid or Upland areas of the Reserve such that they are no longer classifiable as Grassland.

Both Henkel (1937) and Downing (1974) agreed that fire could determine the extent of the several communities in the Humid Upland Zone or Highland Region (units 1 and 2); and both authors emphasise the importance of edaphic factors in determining the extent of the various communities in the Intermediate and Dry Valley Zones (or Riverine and Lowland Regions) embracing units 3 to 6. The relative instability of the Highland communities is therefore not surprising because of the enormous variability possible in the kinds of fire treatment—let alone in the accompanying effects of grazing and browsing by herbivores in this Region. Similarly, the stability of the Riverine and Lowland communities is only to be expected because the nature of the soils is unlikely to change appreciably within many years. Some considerable increases in shrub density are, however, recalled by the late Professor A. W. Bayer (pers. comm.) who assisted Henkel.

CONCLUSIONS AND SUMMARY

1. In spite of some minor errors, equivalent to about 1%, the vegetation survey of Henkel (1937) was sufficiently accurate for meaningful comparison with a survey based on modern methods.
2. Few, if any, boundary changes could be detected from communities in the Riverine and Dry Valley (or Lowland) zones although soil erosion may have accelerated in the Lowlands.
3. The shape of Forest patches has certainly changed over the last forty years, and fairly strong evidence indicates an overall increase in the extent of Forest.
4. The greatest change to have occurred is a decrease in the extent of Grassland and its replacement in many areas by woody categories.
5. The changes in Forest and Grassland are believed due to changes in the nature of fire/browsing interactions on the equilibrium between woody plants and grasses.
6. Relatively stable conditions in the Lowlands are maintained through edaphic control because the extent of each plant community is limited by a specific soil type.

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